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## Research Article

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## Dual fixation for coracoid fracture with acute acromioclavicular joint disruption: A case series

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### Abstract

**Introduction:** Management of concomitant coracoid fracture with acute acromioclavicular joint disruption has been a matter of debate. The coracoid component is not always radiographically recognized; thus, this combined orthopedic injury is not often common. Management options varied from conservative to surgical management with single or dual fixation strategy. This study aimed at outcome evaluation of clavicular hook plate with coracoid screw fixation in athletics and patients with high-demand activities for at least one year follow-up. **Material and methods:** Included patients underwent fixation through clavicular hook plate and coracoid screw. The hook plate was removed after an average period of 16.1 weeks, rehabilitation program was followed. Patients were subjected at final follow-up visit to clinical assessment via ROMs, constant, and ASES scores. Besides, radiological judgement of acromioclavicular joint reduction as per CCD and CCD ratio. **Results:** The average ASES Scores were  $39.1 \pm 14.6$ ,  $67.4 \pm 11.5$ , and  $86.7 \pm 5.7$  at 3, 6, and 12 months, respectively with a statistically significant improvement in between (P-value <0.001). The mean active shoulder abduction and forward elevation ROMs were  $156.4^\circ \pm 12.8^\circ$  and  $171.4^\circ \pm 6.3^\circ$ . The average CCD was  $9.04 \pm 0.9$  mm (7.6-10.2 mm), and the mean CCD ratio was  $1.07 \pm 0.03\%$  (1.01-1.11%). **Conclusion:** Dual fixation via hook plate and coracoid screw without CCL reconstruction provides a stable fixation construct with considerable functional and radiological outcome in high demand patients with acute traumatic ACJ disruption combined with coracoid fracture. **Study Design:** Case series study.

**Keywords:** Acromioclavicular joint, Coracoid, CCD, CCD ratio, Hook plate.

### INTRODUCTION

Acute traumatic acromioclavicular joint (ACJ) disruption associated with coracoid fractures is extremely rare [1]. Management options reported in literatures varied from conservative to surgical management with more superiority to surgical ones regards the functional outcome [2]. In view of absence of solid evidence regards the ideal fixation modality through surgical management of such injuries, and with only case reports without considerable follow-up period, we undertook this research to consider the efficacy of clavicular hook plate and coracoid screw fixation without ligamentous reconstruction for management of this combined injury in athletics and patients with high-demand activities.

### PATIENTS AND METHODS

Between March 2018 to October 2022, seven patients were enrolled in this study who underwent management for acute traumatic ACJ disruption combined with coracoid fracture via open reduction and stabilization by clavicular hook plate and coracoid screw. This research has been approved by the institutional research board of the authors' affiliated institution in line with the principles of the Declaration of Helsinki.

The inclusion criteria were skeletally mature patients  $\geq 18$  years, acute coracoid fracture combined with ACJ disruption Rockwood [3] type III or more, managed by a clavicular hook plate and coracoid screw, within 3 weeks of trauma, with a minimum follow-up period of 12 months. The exclusion criteria were chronic injuries, ACJ disruption Rockwood types I, II, open injuries, concomitant shoulder injury including associated scapular or humeral fractures, concomitant neurovascular injuries, previous shoulder injury, and follow-up less than 12 months.

Preoperatively, a careful radiological evaluation, taking advantage of anteroposterior view radiograph of both shoulders to grade the ACJ disruption as per the traditional Rockwood classification, and delineate the

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site of coracoid fracture. Additionally, computed tomography (CT) scan was obtained in all cases to detect coracoid injury site.

Under general anaesthesia combined with preoperative ultrasound-guided interscalene block, patients were in a beach-chair position with a sandbag under the scapula. All bony prominences were secured and well padded. Patient's arm was draped free allowing intraoperative manipulation of the limb and easy fluoroscopic access. Satisfactory fluoroscopic views were obtained before starting surgery.

### Surgical technique

After palpation of coracoid process, a Longitudinal shaped skin incision was made along the anterior border of the lateral third of the clavicle, starting medial and posterior to ACJ, and curved medially outward the ACJ. The incision was extended distally 2 to 3 cm inferior to the coracoid tip. The anterior deltoid insertion with the periosteum was incised along the skin incision exposing the ACJ. Stay sutures were placed through anterior deltoid fibers for later reattachment. The ACJ, coracoclavicular ligament (CCL), coracoacromial ligament (CAL), coracoid process, and conjoint tendon were identified.

Reducing the ACJ separation was performed using a titanium clavicular hook plate (DePuy Synthes) (4 or 5 hole) with a 15mm-hook offset. The hook was passed into a 5 mm-snip in the trapezium muscle passing beneath posterior aspect of the acromion. The plate was then secured by three to four screws inserted from medial to lateral aiming at indirect reduction of the clavicle into its position. Reduction was checked under fluoroscopy. Afterwards, the coracoid bed on top of the glenoid was prepared and coracoid was temporarily reduced with a Kirschner (K) wire, subsequently, stabilized by a 4mm-partial cancellous screw after being drilled under fluoroscopic guidance. A care was taken not to attack the glenoid articular surface. The CCL and CAL were neither repaired nor reconstructed in any of cases. At the end of procedure, the anterior deltoid along with delto-trapezoidal fascia were repaired. Wound was closed in layers.

Post-operatively, arm sling was used for 2 weeks till stitches removal. Under the guidance of a physiotherapist, Progressive passive and active-assisted shoulder exercises were initiated from three weeks postoperatively, with a strengthening exercise program starting six weeks postoperatively. Patients were advised to restrict abduction of the affected shoulder to 90°, external rotation to 30°, and forward flexion only and to avoid sports and heavy physical activity until the plate was removed [4].

All patients underwent plate removal after an average period of 16.1 weeks (15–18 weeks) and subsequently commenced shoulder rehabilitation program [4] including cuff-strengthening exercises to regain ROM. Patients were able to return to work after twelve weeks, contact sports were allowed after twelve months.

The patients were followed up for minimum 12 months after plate removal. The patients were subjected to clinical assessment at 3 months, 6 months, 12 months post removal, and at the last visit. The functional outcome was assessed using the Constant-Murley score [5,6], and the american shoulder and elbow surgeons assessment scoring system (ASES score) [7]. Active shoulder ROMs and pain grade as per the visual analogue scale [8] were documented at the last visit. Radiological assessment at the same follow-up intervals included ACJ congruency and coracoclavicular distance (CCD) observation. Bilateral shoulder AP radiographs at the final follow-up visit were utilized to evaluate ACJ reduction, besides, the CCD was measured [9], which was defined as the perpendicular distance between the highest upper border of the coracoid process and the opposing lowest inferior cortex of the clavicle (Fig.1). The CCD ratio [4] was also calculated by dividing CCD of injured shoulder to that of the sound shoulder (surgery side CCD/opposite side CCD).

### Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0. Data were reported as (minimum–maximum) or means  $\pm$  standard deviations. All data were tested for normal distribution using the Kolmogorov–Smirnov test. Subsequently, the data were compared using the nonparametric Mann–Whitney U-test for independent samples and Student's t-test for dependent samples. The level of significance was defined as  $P < 0.05$ .

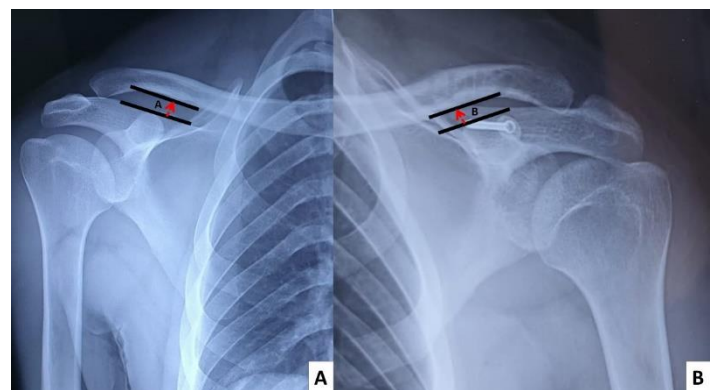
### RESULTS

All included patients were males, accounting for one dentist, three athletes, and three manual workers with heavy duties. The mean age of enrolled patients was  $32.7 \pm 6.4$  years (24–43 years). The mechanism of injury was sports injuries in three cases (42.9 %) and road traffic accident in four cases (57.1 %). Three of the patients (42.9 %) had injury in their dominant arm. All the patients had acute injuries (within three weeks), with average duration of surgical intervention of  $10.9 \pm 6.5$  days (4–21 days) from the injury. Coracoid was fractured at its base in all cases. Five patients had Rockwood's type III AC dislocation (71.4 %) and two patients with type V (28.6 %). All patients were operated by a senior trauma orthopedic surgeon with more than ten years' experience.

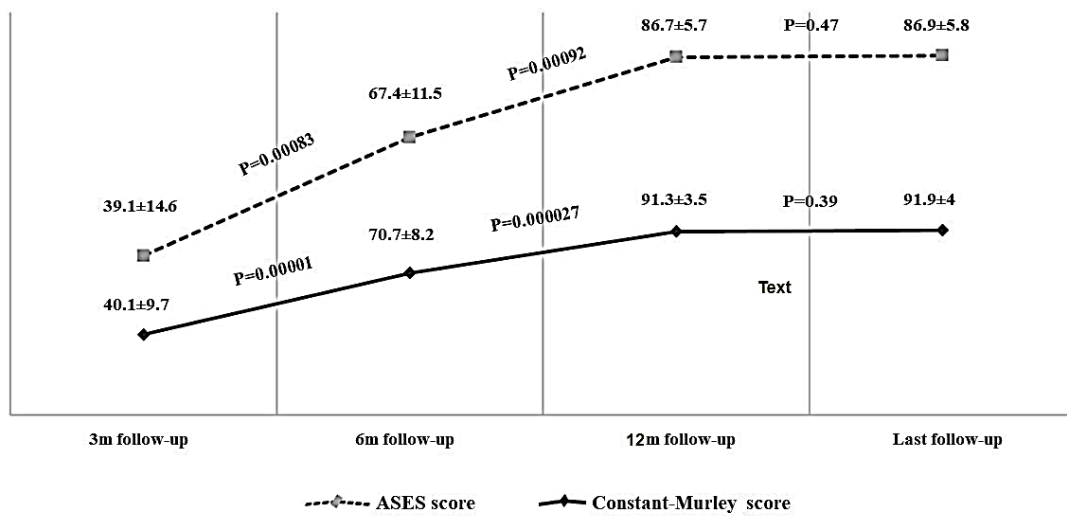
All patients were taken up for removal of the hook plate after an average period of  $16.1 \pm 1$  weeks (15–18 weeks). All but one patient, were compliant for the postoperative rehabilitation program. The mean follow-up period was  $17.6 \pm 1.3$  months (16–20 months) after fixation and an average of  $13.6 \pm 1.3$  months (12–16 months) after plate removal.

The functional outcome was assessed after plate removal. The average Constant Score at 3 months post-removal was  $40.1 \pm 9.7$  as compared to  $70.7 \pm 8.2$ ,  $91.3 \pm 3.5$ , and  $91.9 \pm 4$  at 6 months, 12 months, and last visit respectively. A statistically significant improvement was reported between follow-ups ( $P$ -value  $< 0.0001$ ) as shown in Fig 2. The mean ASES Scores were  $39.1 \pm 14.6$ ,  $67.4 \pm 11.5$ ,  $86.7 \pm 5.7$ , and  $86.9 \pm 5.8$  at 3, 6, 12 months and last follow-up respectively, after plate removal, which showed a statistically significant improvement as well ( $P$ -value  $< 0.001$ ) as shown in Fig. 2. The functional evaluation at the last follow-up revealed an average pain grade of  $1.4 \pm 0.8$  as per the VAS scale. Patients had achieved a mean active overhead abduction and forward elevation ROMs of  $156.4^\circ \pm 12.8^\circ$  and  $171.4^\circ \pm 6.3^\circ$  respectively.

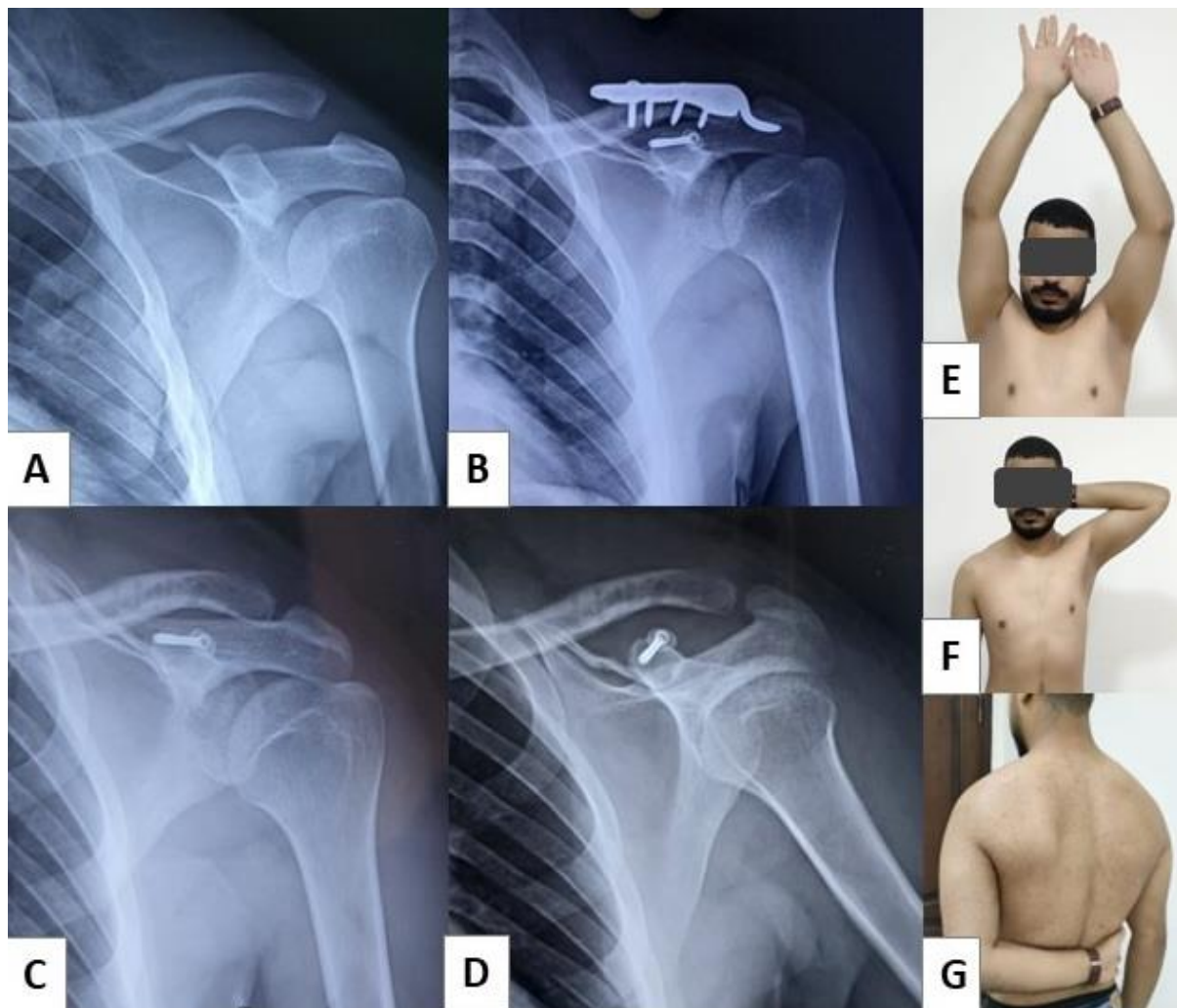
The final radiographs (Fig. 3, 4) revealed neither ACJ subluxation nor dislocation, and no osteolysis at distal clavicle. The CCD of injured shoulder was comparable to other shoulder. The average CCD was  $9.04 \pm 0.9$  mm (7.6–10.2 mm), and the mean CCD ratio was  $1.07 \pm 0.03\%$  (1.01–1.11%).



**Figure 1:** (A)- CCD of the sound shoulder =A-distance. (B)- CCD of the sound shoulder =B-distance, and CCD ratio = surgery side CCD/opposite side CCD (B/A).

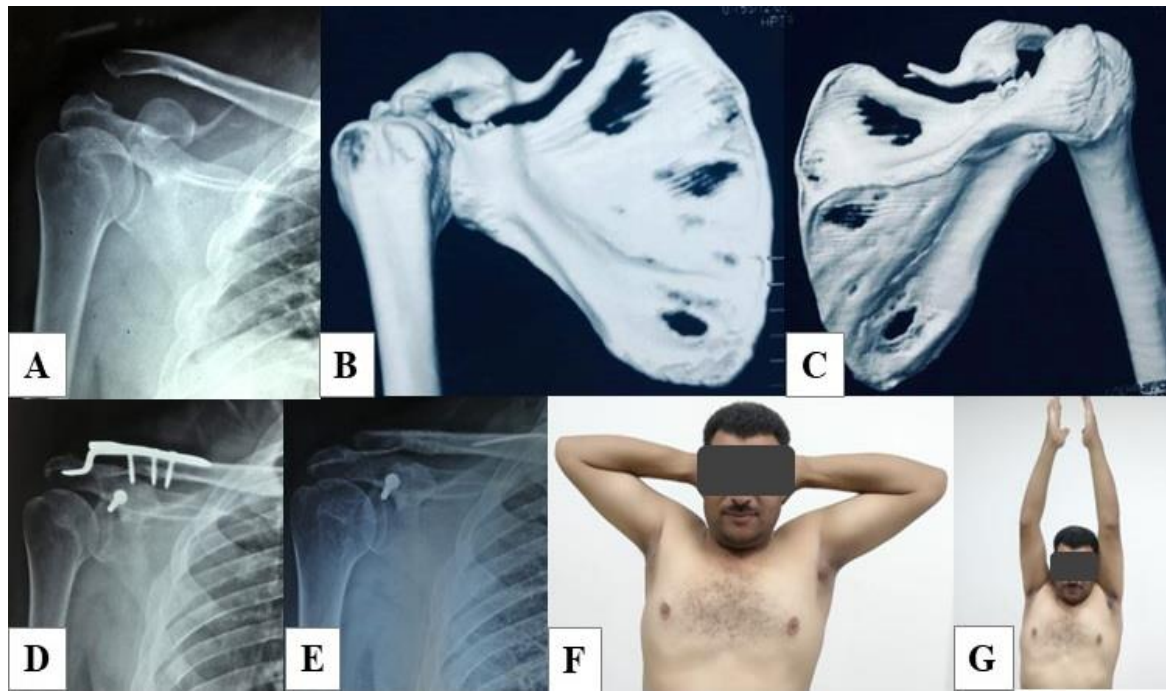


**Figure 2:** Curve chart showing postoperative ASES and Constant-Murley scores at subsequent postoperative follow-up visits



**Figure 3:** (A): Preoperative radiograph of a 24-year-old male patient showing ACJ disruption grade III with coracoid base fracture. (B): Postoperative shoulder radiograph showing good reduction via hook plate and coracoid screw. (C, D): Shoulder radiographs after hook plate removal showing ACJ congruency with united coracoid fracture. (E, F, G): Shoulder ROMs after one year





**Figure 4:** (A): Preoperative radiograph of a 43-year-old male patient showing ACJ disruption and coracoid fracture. (B, C): Preoperative 3D CT images revealing coracoid fracture site. (D, E): Postoperative shoulder radiographs following fixation, and plate removal showing ACJ congruency. (F, G): Shoulder ROMs after one year

## DISCUSSION

Acute traumatic ACJ disruption associated with coracoid fracture is considered uncommon. This rare injury was documented as case reports in the literature. It was managed either conservatively [10-19] or surgically. Surgical management included fixation of ACJ alone [2, 20-23], coracoid alone [24,25], or both simultaneously [1, 26-33]. A consensus never exists regarding the best way of management especially with the reported comparable clinical results of conservative and surgical strategies [2]. The surgical decision often depends upon the patient's activities and associated injuries.

Good to excellent results were reported with conservatively managed injuries, however, patients with light duties and lower grades ACJ disruption were included [12, 13, 23, 25]. Notwithstanding, reported results were slightly inferior to surgical management [2]. Additionally, ACJ pain, cosmetic problems, and weak shoulder musculature might persist after conservative management [2].

This combined injury represents a double break in the superior shoulder suspensory complex (SSSC), with a compromise to the integrity between the clavicle and scapula [24, 29, 34] that might necessitate rebuilding the suspensory complex circle at one or both points. Hence, we preferred to fix both breaks to regain SSSC integrity

Our case series followed a uniform way for fixation taking the advantage of clavicular hook plate with a coracoid screw, to reach a rigid fixation. This management allows for early ROM and return to normal routine activities, additionally, it guards against coracoid nonunion through reducing muscular displacing forces on coracoid process. This can provide a chance for CCL or its remnants to heal without the need for ligamentous reconstruction. Coracoid pseudoarthrosis was reported in literature with ACJ fixation and conservative management of coracoid process, however, the patient experienced excellent short-term outcome [2].

Reported cases with the same injury aged between 9 and 60 years, with a median of 23.5 years [33]. The mean age of patients in this study was  $32.7 \pm 6.4$  years (24-43 years). The mode of combined ACJ and coracoid injuries often mimics that of isolated ACJ disruption, except for, the

coracoid fracture allows for more clavicular superior displacement with no or inconsiderable CCL injury [23]. Rockwood type III disruption represented the main type in our patients (71.4%). The resultant traction forces by CCL yields this combined fracture pattern [21, 35]. As per the Ogawa et al classification, coracoid fractures can be differentiated into two types depending upon its attachment to CCL. Types I and II represent fractures behind and in front of CCL attachment, respectively [36]. Almost all cases with combination injuries had coracoid base fractures [2], similarly, all patients in this study showed coracoid base fractures (type I Ogawa).

In this series, the coracoid fracture was stabilized after ACJ, leaving no stresses on CCL or its remnants to guard against any superadded ligamentous damage risk. The status of preoperative CCL integrity among patients might be questioned, and often depends upon the grade of ACJ disruption. We preferred not to reconstruct ligamentous structures on acute setting, the joint was stabilized within  $10.9 \pm 6.5$  (4-21) days of injury. Internal splinting of the ACJ via hook plate maintains the joint reduced during the time necessary for biological healing of CCL or its remnants, and adds more stability [37].

All patients underwent hook plate removal after an average period of  $16.1 \pm 1$  weeks, with continuation of the rehabilitation program with shoulder muscles strengthening. Patients experienced significant improvement in ROM, and function during subsequent follow-ups.

Considering the preinjury activity performance of injured patients, the debate of surgical versus conservative management might be overlooked in this injury pattern (double disruption of SSSC), particularly in athletes and patients with heavy duties [38, 39]. The goal of management was to regain their pre-injury level of activities, this was achieved in all patients in our study, like antecedent reports where hook plate was used [37, 39].

Vertical stability and integrity of ACJ were achieved in all cases, radiographs revealed an average CCD of  $9.04 \pm 0.9$  mm (7.6-10.2 mm), and the mean CCD ratio was  $1.07 \pm 0.03$  (1.01-1.11%). In this study, we had no surgical site infection, no incidence of ACJ subluxation or dislocation after plate removal. There was no need for further surgeries except for the removal of hook plate.

Study limitations were represented in its retrospective design, non-comparative nature to other management ways, and the limited number of involved cases. Additionally, ACJ horizontal stability was not checked among cases. Further comparative studies involving a larger number of patients are recommended. The strength of our research could be represented in advocating the same way of management for a considerable follow-up period, along with clinical and radiological assessments via validated clinical and radiological parameters.

## CONCLUSION

Dual fixation via hook plate and coracoid screw without CCL reconstruction provides a stable fixation construct with considerable functional and radiological outcome in high demand patients with acute traumatic ACJ disruption combined with coracoid fracture.

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**Conflict of interest:** Authors have no conflict of interest.

**Authors' Contribution:** MSA reviewed and collected patients' records. AE performed statistics and wrote the manuscript. Both authors revised the manuscript.

**Informed consent:** Informed consent was obtained from all individual participants included in the study.

**Ethical approval:** This research has been approved by the institutional research board of the authors' affiliated institution in line with the principles of the Declaration of Helsinki.

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